REMARKS

Claims 34, 36, and 38-68 were in this case. Applicants have canceled claims 34, 36, 38-53 and 55-68 replaced them with new claims 69-95. The subject matter of many of the canceled claims have been retained in the new claims. The claims have been rewritten for consistency in the ordering of the claims and to facilitate review and examination. Claim 54 which depended from claim 36 has been rewritten in independent form. Applicant notes that claim 54 was not rejected under 35 U.S.C. § 103. Applicant respectfully requests reconsideration of the claims as presently in this case. Claims 54 and claims 69-95 are now in this case.

Amendment of the Specification

The specification has been amended to change the cross-reference to related applications to indicate that this application is a continuation of U.S. patent 6,110,354. This is consistent with the position taken by the Examiner with respect to the relationship of this application and its parent and is consistent with the addition of apparatus claims herein.

The specification has been amended to correct the "Abstract of the Invention" on page 37. The Abstract as filed contained obvious errors. The amended abstract is that taken from the parent patent 6,110,354 and is thus fully supported in the specification. This amendment does not add new matter to the specification.

Amendment of the Claims

Claims 34, 36, and 38-68 have been cancelled and replaced with new method claims 69-88 and claims 89-95 directed to microband electrode array sensors. New claim 69 is similar in subject matter to claim 34, the language of the claim has been amended to be more consistent with the language of claims in the parent patent adding the recitation that the size of each gap is selected such that "in operation the signals produced by said microband electrodes in said array are additive." This recitation is supported in the specification in the paragraph bridging pages 4-5. Step (b) of claim 69 recites "applying a voltage to said electrodes and scanning the voltage over a range such that said analyte should be oxidized or reduced at said microband electrode."

The language of step (b) of claim 34 is retained in claim 70. The amended recitation in step (b) of claim 69 is considered to better recite what Applicant believes to be the invention. The new recitation is in part supported in claim 34 and in part supported in claims 38, 42 and 43. Claim 38 recited that an electrical potential (or voltage) was applied to the sensor (i.e. to the electrodes of the sensor), claims 42 and 43 recited that the voltage should be scanned to reduce and oxidize the analyte, respectively. Method claims 69-88 retain the specific recitation that the width and thickness of the electrode's exposed surface are less than about 25 micrometers.

New claims 89-95 are directed to microband electrode array sensors wherein "each of said microband electrodes has a width less than about 25 micrometers and a thickness less than about 25 micrometers; and wherein the size of each gap is selected such that in operation, the signals produced by said microband electrodes in said array are additive." These claims are added to better claim the invention and in part because the Examiner has taken the position that this application is a continuation of the parent patent which contains claims to an array sensor and to methods of using that sensor.

The new claims are fully supported by the specification, including the as-fled claims, and do not represent the addition of new matter.

As indicated below claim 54 was rejected only under the judicially created doctrine of obvious-type double patenting. It is believed that this rejection is obviated by the filing of a terminal disclaimer herewith. Claim 54, while dependent upon rejected claim 36, was not itself rejected under 35 U.S.C. § 103 and in the absence of a proper rejection must be considered to be allowable if rewritten in independent form. Applicant has rewritten claim 54 in independent form including all of the limitation of the claim from which it depends. In view of the rejections of record, amended claim 54 should be considered allowable.

<u>Objection to the Drawing</u>

Applicant notes that the objection to the drawing has been withdrawn and notes that on page 42 of the Office Action, the examiner indicated that the proposed change to Figure 6A has

been made by a PTO draftsman so that a corrected drawing is not needed. Applicant notes that in anticipation of approval of the correction to Figure 6A, a sheet of formal drawings containing corrected Figure 6A was submitted by Applicant on October 8, 2002. It is believed that no additional correction of drawing formalities are required.

THE REJECTIONS

Double Patenting Rejections

Claims 34, 36, 38-63, 64 (presumably), 65-68 have been rejected under the judicially created doctrine of obviousness-type double patenting over various claims and combination of claims in the parent U.S. patent 6,110,354. Claim 64 was not specifically rejected. However, it is believed that paragraph 26 on page 17 of the Office Action was intended to refer to claim 64 rather than claim 54. Applicant submits herewith a terminal disclaimer over U.S. patent 6,110,354 to obviate the obviousness-type double patenting rejection. Applicant notes that new claims 89-93 which are directed to microband electrode array sensors should not been subject to restriction in this case in view of the position taken by the Examiner that the present application is a continuation of the parent patent.

Applicant emphasizes that amended claim 54 and the new claims in this case are not identical to the claims in parent patent 6,110,354. Applicant believes that the filing of the terminal disclaimer with this response obviates all issues of double patenting with respect to the claims presently in this case.

Applicant has the following comments on the Examiner's statements on pages 2-4 of the Office Action regarding the restriction requirement imposed during prosecution of the parent Application. In response to the restriction requirement in the parent application, Applicant elected the claims of Group I with traverse and presented an amendment of the claims in which the method of use claims were directed to the use of a claimed apparatus (that of claim 2) and the methods of making the sensor where also directed to making a claimed apparatus (that of claim 2). Thus, Applicants argued that claim 2 was an allowable, proper linking claim between the

three Groups of claims that had been restricted. The Examiner agreed noting that the rejoinder was granted because all of the claims depended from an allowed apparatus claim. Applicant never argued that the "non-elected claims were in fact not patentably distinct." Applicant understood that rejoinder was granted because of the amendment and the presence of an allowable linking claim.

Claim Rejection under 35 U.S.C. § 102

Applicant understands that all of the rejections under 35 U.S.C. § 102 have been withdrawn.

Claim Rejections under 35 U.S.C. § 103

Claim Rejections based on Thorman

Claims 34, 38, 39, 41, 50-52 and 60-62 are rejected as unpatentable over Thorman et al. Claims 36 and 55-57 are rejected as unpatentable over Thorman in view of Wojociechowski. Claims 40 and 43 are also rejected as unpatentable over Thorman in view of Wojciechowski. Claims 42 and 43 are rejected as unpatentable over Thorman in view of De Castro. The rejected claims have been cancelled, however the subject matter of the rejected claims has, at least in part, been retained in claims 69-91. Applicant respectfully traverses these rejections with respect to the claims presently in this case.

New claim 69 and claims that depend there from are methods for use of a specific microband electrode array sensor which recite "contacting the sensor with a sample suspected of containing an analyte; and applying a voltage to the electrodes and scanning the voltage of the sensor over a range such that said analyte should be oxidized or reduced at said electrodes." The sensor is recited as having "a substrate having a first edge; a layer of insulating material having a first edge aligned with said first edge of said substrate; and a plurality of microband electrodes between said substrate and said layer of insulating material; said microband electrodes having a surface exposed at said first edges of said substrate and said insulating layer, said insulating material forming a plurality of gaps, wherein there is one gap between each of two adjacent

microband electrodes, wherein the exposed surface of each of said microband electrodes has a width less than about 25 micrometers and a thickness less than about 25 micrometers; and wherein the size of each gap is selected such that in operation, the signals produced by said microband electrodes in said array are additive." This recitation is analogous to the language employed in the issued claims in the parent patent in reciting that the signals are additive and additional recites that the thickness of the exposed electrode surfaces are less than about 25 micrometers. Applicant also stresses that the recitation originally in claim 34 that the gaps between electrode surfaces has "a length great enough that no substantial overlap of diffusion layers occurs" has not been retained in claim 69 and its dependents. Rather as noted above claim 69 recites that in operation the signals generated by the electrodes are additive.

In support of the rejections over Thorman, the Examiner states that Thorman's teaching that there is "only a small interaction between adjacent sensing elements" with a 30 micron gap length "arguably implies" Applicant's original recitation that the gap have length great enough for no substantial overlap of diffusion layers. The Examiner further states that Thorman teaches that "with a <u>large</u> gap length the response at each sensing element becomes additive," and that it would have been obvious to one of ordinary skill in the art "to have the gap length large enough so that the response at each sensing element becomes additive."

As a first matter, when the Thorman reference is considered as a whole it is not clear what it teaches with respect to additivity of electrode signals as a function of spacing. Statements in Thorman appear to be inconsistent. For example, on page 2764 of the reference (first page) in the Abstract in bold, the authors state that "the response of the array is close, but not exactly equal, to the sum of the individual sensing elements." This statement indicates that the arrays described in the reference exhibit non-additivity. In comparing, Array I and Array VI, in Table II, the authors state that the three electrodes (Array I) "provide a signal that is always slightly larger than the sum of the individual currents," and state that with Array VI that the limiting dc currents of individual sensing elements are "additive within experimental error." (See paragraph bridging pages 2766-2767 of the reference.) Finally, on page 2769 in a discussion of the Dc and transient voltammetric data of Table III, which only contains data on Array VI, the authors again

state that the important point to be established is the "near-additivity of linear arrays. The distinct in Thorman as to what is additive and what is near additive is thus unclear. Further, Array VI and Array I differ in ways other than just in the spacing between electrodes. Array I is an array of only three electrodes with width of 15 micrometers separated by a gap of 30 micrometers in contrast Array VI is an array of 100 electrodes with width of 250 micrometers and separated by a gap of 760 micrometers. Furthermore, the authors state at the bottom of column two on page 2766 in the paragraph bridging pages 2766 and 2767 in reference to Array I that "it is somewhat difficult to obtain equal signals because of the inequalities in the polishing. This statement suggests that the non-additivity observed in the data of Table II could simply be the result of differential polishing of the electrodes. It would be expected that data from an array containing only three electrodes might be more affected by differential polishing than an array like Array VI which contains 100 electrodes.

Thus, when viewed as a whole for what it teaches and suggests it is not clear that the Thorman reference unequivocally teaches to one of ordinary skill in the art that increasing the gap between electrodes in an array of electrodes actually results in additive behavior. It is unclear based on inconsistent statements in the reference that the data obtained from Array VI is in fact additive. Further, it is unclear that the authors statements on the effect of changing the electrode spacing based on their comparison of data from Array I and Array VI which different not only in spacing, but also in number of electrodes, possible quality of polishing of electrodes and in size of the electrodes are supported by their experimental results. Any suggestions in Thorman are, in fact, based on a comparison of the properties of two electrode arrays that are different in more than one structural property. Due to the equivocal nature of the teachings and suggestions in Thorman, Applicants submit that the reference provides no clear teaching that increasing the gap between electrodes in the electrode arrays studied leads to additive behavior of sensor arrays. Specifically, the Thorman reference provides no clear teaching that increasing the gap between electrodes in which the electrode width is 25 micrometers or less would result in an electrode array exhibiting additive behavior.

As noted above, Thorman did not teach or suggest the combination of electrode widths less than 25 micrometers and gaps between the electrodes that would lead to additive behavior that are claimed by Applicant. Even if one assumes that Thorman's teaching with respect to the

behavior of Array VI is unequivocal (which Applicant submits it is not), Thorman at most teaches that electrodes having both larger width than is claimed by Applicant and larger gaps between electrodes (e.g., widths of 100 micrometers and a gap of 760 micrometers) exhibit "additive" or "near-additive" behavior. Thus, in a sense Thorman can be seen to teach that one can obtain additive properties by increasing electrode width in combination with increasing electrode gap size.

Claim 69 and its dependents require that the length and width of the electrode surface is less than about 25 micrometers. Thorman does not teach or suggest an electrode surface having such limits on both of these dimensions. Thorman does not in fact teach that there is any benefit to be achieved in the use of microelectrodes with such limited dimensions.

As noted in the specification at page 8, the dimensions of the electrode at its exposed surface and the spacing between electrodes of the microband arrays of this invention result in true steady-state behavior. Applicants direct the Examiner's attention to the response filed by Applicant in the prosecution of the parent patent (on June 24, 1999) which is repeated herein and includes a copy of a declaration of inventor Saban originally submitted in that response.

Applicants have found that, contrary to what was generally accepted in the art at the time the invention was made, a microband electrode array of the dimensions as presently claimed can achieve steady-state within a time that is practical for making electrochemical measurement (e.g., within 5 sec.). This property results in more reliable sensors with better signal to noise and reduced capacitive effects (specification at page 29).

As noted above, Thormann teaches 7 linear electrode arrays. One of the arrays has a electrode width of 15 micrometers and an intra electrode spacing of 30 micrometers. The other arrays all have electrode widths of 60 or more micrometers and intra electrode spacing of 340 or more micrometers. None of Thormann's arrays combines small electrode width and thickness (less than 25 micrometers) with longer spacing of the electrodes to prevent overlap and interference. As noted above, Thorman's teachings and suggestions with respect to the possible

effect of changing electrode widths on electrode properties are equivocal. There is no teaching or suggestion that any improvement in electrode properties would be obtained by making the widths of the electrodes 25 micrometers or less. There is no teaching or suggestion that steady-state behavior of electrodes might be improved by decreasing the width of the electrodes to 25 micrometers or less. In fact, Thormann generally teaches away from the use of his array I electrode with the smallest 15 micrometer electrode width because the electrodes of that array were not additive. All of the Thormann electrodes that showed additive behavior had widths greater than 25 micrometers. Thormann provides no motivation that would lead one of ordinary skill in the art to combine decreased electrode width with increased electrode spacing.

Cyclic voltammograms are presented in Thormann in Fig. 3 for array I and in Fig. 4a for the gold 100 element array (presumably array VI). On page 2765 column 1, the authors state that their electrodes yield steady-state voltammetric responses at convenient rates of potential scan. However, the cyclic voltammograms of Fig. 3 and Fig. 4a do not exhibit steady-state behavior as understood in the art, as understood by Applicant and described by them in the specification or as described by two of the coauthors of the Thormann reference in a later paper. Further, in Thormann on page 2767, second column, the authors appear to contradict their earlier statement about steady-state behavior when they report a "slight dependence of i_l (limiting current) on scan rate" for all electrode arrays and indicate that this would not be "predicted for purely spherical (steady state) diffusion." Applicant notes that this is another example of the inconsistent teachings of Thorman.

Applicants provide the reference Bond et al. J. Phys. Chem. (1986) <u>90</u> :2911-2917 coauthored by two of the coauthors (Bond and Thormann) of the cited Thormann et al reference. Bond relates to linear microelectrodes with submicrometer thickness and illustrates cyclic voltammograms in Fig. 3 at different scan rates. The authors indicate in column 2 of page 2914 that the cyclic voltammograms of Fig. 3 do not show steady-state behavior. In the discussion beginning at the bottom of column 1 on page 2914, through the top of column 1 on page 2915, the authors indicate that a steady-state voltammogram exhibits complete overlap of the forward and reverse scans at slow scan rate. Because the cyclic voltammograms in Fig. 3 of Bond show

a separation in the forward and reverse scans, they are not classifiable as steady-state voltammograms.

When the cyclic voltammograms of the Thormann reference are considered in light of the discussion in the Bond paper, it is clear that the results in Thormann in Fig. 3 (for array I) and Fig. 4a (for array VI) do not show complete overlap of the forward and reverse scans and are not indicative of the electrode array reaching a steady state. In contrast, Applicants microband electrode arrays exhibit cyclic voltammograms and chronoamperometric graphs indicative of steady-state behavior.

Submitted herewith is the declaration of Stevan B. Saban one of the co-inventors of this invention (which is a copy of the declaration submitted in prosecution of the parent application hereto.) In this declaration Dr. Saban presents a cyclic voltammogram of a microband electrode having 24-Au electrodes. The electrode width is 10 micrometers, the electrode thickness is 0.18 micrometers and the spacing between the electrodes is 400 micrometers. The voltammogram shows complete overlap of the forward and reverse scans at a scan rate of 200mV/s. In contrast, Fig. 4a of Thormann which provides the cyclic voltammogram of array VI (electrode width 250 micrometers, thickness 0.2 micrometers and spacing 760 micrometers) at almost the same scan rate (250 mV/s) shows significant separation of the forward and reverse scan. Also in Fig. 3 for Thormann's array I, where the electrode thickness is reported to be 15 micrometers, the cyclic voltammogram shows significant separation even though the scan is run at a significantly slower rate (50 mV/s).

A cyclic voltammogram for Applicant's microband 24-electrode array was provided in the specification in Fig. 11 (heavier line) and showed a slight deviation in the forward and reverse scans. Dr. Saban explains in his declaration that the derivation observed in Fig. 11 is characteristic of a leaky seal. (The separations observed in the voltammograms of Thormann are not characteristic of leaky seals). Applicant had noted in the specification at page 28 (bottom of the page) that the array of twenty-four Au electrodes at that time exhibited an unusually high limiting current believed due to a less than ideal seal. Dr. Saban also states that the cyclic

voltammogram of exhibit A was measured with the same microband array of twenty-four Au electrodes that was used to obtain the voltammogram of Fig. 11, except that the surface of the array had been repolished. Repolishing corrected the seal leakage in the electrode.

As further defined in the specification at page 8, steady-state electrode behavior is shown when a chronoamperometric measurement (current versus time) displays a horizontal asymptote, i.e. the current measured does not substantially change with time after equilibration. Fig. 9 in the specification is the chronoamperometric graph for the 24-Au electrode array which shows steady-state behavior is achieved in Applicants' array within less than about 2 seconds.

Thormann's electrode arrays do not achieve steady-state behavior as defined by Applicants and as understood in the art. Thormann does not teach any benefits that would be obtained on improving the steady-state behavior of microband electrodes and does not teach or suggest how improved steady-state behavior can be achieved.

Further, the declaration provided herein and the Bond reference further support Applicant's argument that the teachings of the Thorman reference are equivocal.

Thus, Thormann alone does not make obvious Applicants' claimed electrode arrays in which the dimensions of the electrodes are of a selected small width less than about 25 micrometers and a thickness less than about 25 micrometers to obtain improved steady-state behavior.

Applicant respectfully requests withdrawal of all rejections based on the alleged teachings of Thorman.

Certain claims (as noted above) were rejected based on the combination of Thorman and Wojciechowski or De Castro. Wojciechowski is characterized as teaching performing anodic stripping voltammetry. De Castro is characterized as teaching performing anodic or cathodic stripping voltammetry. Neither of these references cures the deficiencies of the Thorman

reference. Neither of these references provides an unequivocal teaching or suggestion that electrode arrays of the claimed dimensions will exhibit steady-state behavior. Thus, all rejections based on the combination of Thorman and Wojciechowski or Thorman and De Castro should be withdrawn.

Rejections based on Thorman in view of Williams

Claims 44 and 45 are rejected as unpatentable over Thorman in view of Williams. Although claims 44 and 45 have been cancelled, subject matter of these claims has been retained in the new claims. Applicant respectfully traverses this rejection with respect to the claims presently in this case.

The Thorman reference has been discussed above and those arguments are incorporated in the response to this rejection. Williams is characterized in this rejection as disclosing a microband electrode array having an array of sensors separated from each other by insulating material in which additional sensors may be provided in an additional layer of insulating materials. The Williams reference as characterized in this rejection does not cure the deficiencies of the Thorman reference. The Williams reference does not provides an unequivocal teaching or suggestion that electrode arrays of the claimed dimensions will exhibit steady-state behavior. Thus, the rejection based on the combination of Thorman and Williams should be withdrawn.

Rejections based on Williams in view of Thorman and Mochizuki

Claims 34 and 49-51 are rejected as unpatentable over Williams in view of Thorman, Mochizuki and Kuhr. Claims 36, 55 and 56 are rejected as unpatentable over Williams in view of Thorman, Mochizuki and Wojciechowski. Claims 38, 39, 41, 44, 45 and 59-61 are rejected as unpatentable over Williams in view of Thorman and Mochizuki. Claims 40 and 43 are rejected as unpatentable over Williams in view of Thorman and Mochizucki and further in view of Wojciechowski. Claims 40 and 43 are rejected as unpatentable over Williams in view of Thorman and Mochizuki and further in view of DeCastro. Claims 52 and 53 are rejected as

unpatentable over Williams in view of Thorman Mochizuki, Kuhr and in further view of Mattox (page 533 of Handbook of Physical Vapor Deposition (PVD) Processing). Claims 57 and 58 are rejected as unpatenable over Williams in view of Thorman, Mochizuki and Wojciechowski and in view of Mattox. Claims 62 and 63 are rejected as unpatentable over Williams in view of Thorman and Mochizuki and in view of Mattox.

Although the rejected claims have been cancelled. The subject matter of these claims is at least in part retained in the new claims. Applicant respectfully traverses this rejection with respect to the claims remaining in this case.

Williams is alleged to disclose a method of using a microband electrode array sensor having certain elements as claimed herein. Williams as stressed by the Examiner does not disclose electrodes of the dimensions as claimed herein. As noted above, the electrode arrays of the claimed methods have specific dimensions selected to achieve steady-state behavior. Williams does not teach or suggest the specific electrode dimensions to achieve this result and does not teach or suggest gaps between electrodes that are sufficiently large to achieve additive behavior. Mochizuki does not teach or suggest the specific electrode dimensions to achieve steady-state behavior and additive behavior. Mochizuki do not in fact teach any electrode arrays. As stressed above Thorman does not provide a non-equivocal teaching or suggestion with regard to achieving additive behavior in electrode arrays. Thus any combination of Williams, Thorman and Mochizuki cannot provide an unequivocal teaching or suggestion of Applicant's claimed invention employing electrode arrays which have specific selected dimensions to achieve steady-state behavior and additive behavior.

In view of the foregoing all rejections based on the combination of Williams, Thorman and Mochizuki should be withdrawn.

Certain claims are rejected over the on the combination of Williams, Thorman and Mochizuki in further view of Kuhr, Wojceichowski, De Castro and/or Mattox. None of these references alone of in any combination cure the deficiencies of the combination of Williams,

Thorman and Mochizuki. None of these references alone or in combination provides an unequivocal teaching or suggestion that electrode arrays of the claimed dimensions will exhibit steady-state behavior and additive behavior. Thus, these rejections should be withdrawn.

Rejections based on Slater in view of Thorman

Claims 46 and 65-68 are rejected as unpatentable over Slater in view of Thorman. Claim 47 is rejected as unpatentable over Slater in view of Thorman and further in view of Kuhr. Claims 47 and 48 are rejected as unpatentable over Slater in view of Thorman and in further view of De Castro. Claim 64 is rejected as unpatentable over Slater in view of Thorman and in further view of Williams.

Although the rejected claims have been cancelled. The subject matter of these claims is at least in part retained in the new claims. Applicant respectfully traverses this rejection with respect to the claims remaining in this case.

Slater is alleged to disclose methods for use of a microelectrode array having elements as claimed herein wherein the sensor array is integrated into a channel. Slater does not teach anything about the selection of electrode dimensions or gap sizes to achieve additive behavior or steady-state behavior of the electrode array. As stressed above Thorman does not provide a unequivocal teaching or suggestion with regard to achieving additive behavior in electrode arrays and does not teach how to achieve steady-state behavior in any electrode arrays. Electrode arrays of Thorman do not achieve steady-state behavior. Thus any combination of Slater and Thorman cannot provide an unequivocal teaching or suggestion of Applicant's claimed invention employing electrode arrays which have specific selected dimensions to achieve steady-state behavior and additive behavior.

In view of the foregoing all rejections based on the combination of Slater and Thorman should be withdrawn.

Certain claims are rejected over the on the combination of Slater and Thorman in further view of Kuhr, De Castro and/or Williams. None of these references alone of in any combination cure the deficiencies of the combination of Slater and Thorman. None of these references alone or in combination provides an unequivocal teaching or suggestion that electrode arrays of the claimed dimensions will exhibit steady-state behavior and additive behavior. Thus, these rejections should be withdrawn.

All rejections based on the combination of Slater in view of Thorman should thus be withdrawn.

In view of all the forgoing, all of the rejections remaining in this case should be withdrawn.

Conclusion

This amendment is accompanied by a Petition for Extension of Time of three months with requisite fee ($465.00) and a Terminal Disclaimer with requisite fee ($110). A check in the amount of $575.00 is enclosed. It is believed no fee is required for additional claims. If the enclosed amount is incorrect, please charge any deficiency or credit any overpayment to deposit account 07-1969.

Respectfully submitted,

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